ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
1021 NORTH GRAND AVENUE EAST, P.O. BOX 19276, SPRINGFIELD, ILLINOIS 62794-9276 • (217) 782-3397
JB PRITZKER, GOVERNOR JOHN J. KIM, DIRECTOR

MEMORANDUM

Date: May 2, 2024

To: Minesh Patel, Construction Unit, Permits/BOA

From: Rain Sevenshadows, Modeling Unit, Permits/BOA

Subject: Green Plains Madison LLC, ID 119465AAG, Permit Application 23020028

Green Plains Madison, LLC (GPM) submitted a construction permit application (#23020028) on March 20, 2023, for a Maximum Stillage Coproducts (MSC) Project providing for production of a new specialty product (MSC Protein). The MSC Project would require an expansion of the existing ethanol plant that would increase the ethanol production capacity from 100 to 140 million gallons/year. In addition to the equipment associated with the new MSC Protein process, GPM proposed to install new grain milling and fermentation equipment at the existing ethanol plant. This would provide for an increase in utilization to achieve the additional ethanol production. The existing facility is located at 395 Bissell in Madison, Illinois. Centering coordinates for this facility are UTM Zone 15 coordinates 745,281 m Easting and 4,285,496 m Northing.

As of the date of this permitting decision, GPM is located in an area of Environmental Justice ("EJ") concern as identified using Illinois EPA EJ Start. The issued permit would provide for increases in permitted emissions of nitrogen oxides (NOx), carbon monoxide (CO), volatile organic material (VOM), particulate matter (PM) and sulfur dioxide (SO_2). GPM is proposing to decrease $PM_{2.5}$, PM_{10}, acetaldehyde, and total hazardous air pollutants (HAP) permitted emission limits for the plant. Consequently, the Illinois EPA requested GPM submit an air quality analysis as part of its permit application to ensure the project would not threaten or compromise existing National Ambient Air Quality Standards (NAAQS) for any pollutant with an increase in permitted emissions.

In response to Illinois EPA's request, GPM conducted an air quality review for the project's increases of SO_2, NOx, and CO emissions. The Illinois EPA Modeling Unit (Modeling Unit) also independently evaluated the impact that the project's increase in VOM emissions would have on ozone (O_3) formation.

Modeling Unit Review

GPM submitted an air quality analysis summary on December 28, 2023. Modeling files were transmitted electronically to the Modeling Unit on January 3, 2024. GPM submitted a revised modeling analyses and electronic modeling files on March 8, 2024, and March 27, 2024. The

updated modeling analyses provided revised modeled emission rates and reflected revisions to the nearby source domain.

The following main dot entries identify key aspects of the modeling methodology used in this analysis:

- GPM used AERMOD (v. 22112), the AMS/USEPA Regulatory Model. AERMOD is a federally approved regulatory model appropriate for use in an air quality analysis of this nature. While a newer version of AERMOD has since been released (v. 23132), the results from this analysis should not be impacted by use of the updated version. Therefore, as the analysis was initially submitted before the release of v. 23132, the use of v. 22112 was approved for this analysis. The audit runs conducted by the Modeling Unit used v. 23132.

- Modeling inputs utilized IEPA- and USEPA-recommended default regulatory options, which simulate phenomena such as atmospheric stability, plume rise, and downwash. The modeling analysis incorporated five years of locally representative meteorology. The Modeling Unit obtained National Weather Service (NWS) meteorological data files for years 2018 through 2022 from the National Centers for Environmental Information (NCEI) which consisted of surface data collected at Saint Louis International Airport surface station in St. Louis, Missouri, and upper air data collected at the National Weather Surface office in Lincoln, Illinois. Surface and upper air stations were selected because of their proximity and representativeness to the project site in Madison County. The Modeling Unit provided the applicant with meteorology data processed with AERMET (v. 22112). The Modeling Unit used 2018 through 2022 files processed with AERMET (v. 23132) in its review.

- GPM processed National Elevation Data (NED) terrain elevations from USGS using the most recent version of AERMAP (v. 18081) to develop the receptor terrain elevations and hill height scales required by AERMOD. The site elevation at the GPM facility is approximately 126 m above mean sea level.

- GPM used a Cartesian grid in their distribution of 8,227 receptors[1]. The following receptor grid densities were used:
    - 50 m spacing of receptors from approximate midpoint of facility to 1.4 km.
    - 100 m from 1.4 km to 2.4 km.
    - 250 m from 2.4 km to 5.4 km.
    - 500 m from 5.4 km to 7.2 km.
    - 1000 m from 7.2 km to 20 km.

[1] The receptor grid GPM utilized in the 1-hour and 3-hour SO_2 source impact analyses had 8,119 receptors. GPM did not include fence-line receptors in the 1-hour and 3-hour SO_2 source impact analysis modeling. However, GPM did include fence-line receptors in all NAAQS analyses. The Modeling Unit's audit included all fence-line receptors in the SO_2 source impact analyses and NAAQS analyses.

- GPM selected the urban modeling option in their analysis. The Modeling Unit conducted an Auer's Analysis as part of its review to characterize the area surrounding GPM and determine whether the AERMOD urban option should be implemented. The Modeling Unit developed its Auer's Analysis using 2019 National Land Cover Data (NLCD) within a 3-km radius of the facility. Results of the analysis showed that the surrounding area is 50.25 % urban and 49.75 % rural. The Modeling Unit audit also utilized the urban modeling option.

- GPM used USEPA's Building Profile Input Program (BPIPPRM) to account for downwash effects of on-site structures. All on-site nearby buildings were included in the modeling analysis.

- NO_2 modeling options consist of multiple tiers. Tier 1 assumes that all NOx emitted from emission units at the source converts to NO_2. Tier 2 is based upon a representative atmospheric equilibrium default value that was developed using conversion ratios generated from monitored concentrations of NOx and NO_2. Tier 3 allows the user to perform a detailed analysis using either the Ozone Limiting Method (OLM) or the Plume Volume Molar Ratio Method (PVMRM) regulatory screening options in AERMOD. These options consider the chemical mechanism of ozone titration and the resulting NO_2 concentrations. Based on the submitted modeling files, GPM used a Tier 2 approach to model NO_2. GPM selected the regulatory default Ambient Ratio Method (ARM2) option in AERMOD which uses a range of ambient NO_2/NOx ratios, with 0.5 as the lower limit and 0.9 as the upper limit.

Source Impact Analysis

GPM performed a source impact analysis to determine if more detailed modeling would be required for any NOx, SO_2, or CO averaging period. GPM modeled allowable emission increases from the project, which are the difference between the proposed permitted emissions and current actual emissions of existing units at the facility. The results of this analysis are compared against significant impact levels for each pollutant and averaging period. The results of this analysis can be found in **Table 1** below.

Table 1
Source Impact Analysis Results

Pollutant	Averaging Period	Maximum Modeled Impact ($\mu g/m^3$)	Significant Impact Level ($\mu g/m^3$)
NO_2	1-hour	44.28	7.52
	Annual	1.28	1
SO_2	1-hour	43.28[(1)]	7.85
	3-hour	36.78[(2)]	25

CO	1-hour	58.00	2000
	8-hour	37.23	500

(1) GPM reported a maximum modeled impact was 36.31 µg/m^3. See also footnote 1.
(2) GPM reported a maximum modeled impact was 31.03 µg/m^3. See also footnote 1.

Modeling Unit audit runs generally confirmed GPM's modeling analysis; however, results varied for the 1-hour and 3-hour SO_2 modeling scenario as GPM's analysis did not include fence-line receptors. Regardless, the results from both GPM's analysis and the Modeling Unit's audit found that impacts for 1-hour NO_2, annual NO_2, 1-hour SO_2, and 3-hour SO_2 would be above their respective SILs and further analysis was necessary.

GPM also evaluated the secondary $PM_{2.5}$ impacts from the project's increases of NOx and SO_2 emissions, and the Modeling Unit independently evaluated the secondary O_3 impacts from the facility's NOx and VOM emissions. These analyses are discussed in detail in the following section.

Ozone and Secondary $PM_{2.5}$ Formation

GPM considered the precursor emission increases of NOx and SO_2 to evaluate the impact of secondary formation of $PM_{2.5}$ on the NAAQS. Results from the analysis were compared against SILs for $PM_{2.5}$ to determine if further analysis should be completed. While primary $PM_{2.5}$ is emitted directly from the source, secondary $PM_{2.5}$ is formed in the atmosphere from chemical reactions involving precursor emissions. Emissions of NOx and SO_2 are precursors to this secondary $PM_{2.5}$ formation.

Additionally, the Modeling Unit independently evaluated the project's impacts on the ozone (O_3) NAAQS due to the project's increases of VOM and NOx emissions. O_3 formation is a complex, process that is dependent on meteorological conditions as well as concentrations of VOM and NOx. Emissions of VOM and NOx are precursors to O_3 formation.

To estimate the O_3 and secondary $PM_{2.5}$ formation, a Tier 1 demonstration was performed following guidance[2,3] from USEPA on modeled emission rates for precursors (MERPs). This approach utilizes air quality modeling results from hypothetical sources with precursor emission estimates to evaluate the project's impacts on O_3 and secondary $PM_{2.5}$.

A representative hypothetical source in Shelby County, Tennessee was selected from USEPA's MERPS View Qlik[4] tool due to its similarity with the GPM facility. GPM references that the hypothetical source is near a metropolitan area with multiple other pollution sources and near a river valley with land elevation similar to GPM. For the secondary $PM_{2.5}$ analysis, GPM selected

[2] USEPA (2019). *Guidance on the Use of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program*. Publication No. EPA 454/R–19–003. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[3] USEPA (2022). *Guidance for Ozone and Fine Particulate Matter Permit Modeling*. Publication No. EPA 454/R–22–005. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[4] USEPA (2022). MERPs View Qlik. *Support Center for Regulatory Atmospheric Modeling (SCRAM).* Retrieved from: https://www.epa.gov/scram/merps-view-qlik.

the hypothetical source with 500 tpy emissions of SO_2 and NOx and a 10-meter stack height. For the ozone analysis, the Modeling Unit utilized the same location with a 10-meter stack height and 500 tpy emissions of VOM and NOx.

GPM's MERPs calculations were based upon potential emission increases comparing allowable emissions post-project to allowable emissions pre-project. The Modeling Unit results were conservatively based upon post-project allowable emissions of 116.79 tpy NOx, 41.46 tpy SO_2, and 169.3 tpy VOM. The Modeling Unit's results are displayed in **Table 2** below to show a conservative estimate of secondary impacts from the project's precursor emissions.

Table 2
Tier I MERPs Analysis Results for $PM_{2.5}$ and Ozone
Hypothetical Source: Shelby County, TN

Pollutant	Averaging Time	SIL	MERP Values			Total Concentration
			NOx	SO_2	VOM	
$PM_{2.5}$	24-Hour	1.2 μg/m^3	9,957	894	-	0.070 μg/m^3
	Annual	0.2 μg/m^3	30,663	11,537	-	0.001 μg/m^3
O_3	8-Hour	1 ppb	720	-	1,998	0.247 ppb

The Modeling Unit analysis predicted $PM_{2.5}$ impacts of 0.070 μg/m^3 for the 24-hour averaging period and 0.001 μg/m^3 for the annual averaging period; the analysis predicted O_3 impacts of 0.247 ppb for the 8-hour averaging period. All results are below their respective SILs[5], and therefore no further analysis is necessary for either $PM_{2.5}$ averaging period or O_3.

NAAQS Analysis

Based on the results from the source impact analysis, GPM conducted a NAAQS analysis for NO_2 (both 1-hour and annual averaging periods) and SO_2 (both 1-hour and 3-hour averaging periods). GPM developed a cumulative modeling analysis that incorporated background concentrations based on nearby monitoring data as well as a nearby emission inventory sources not represented by the background monitor concentration.

GPM utilized representative background data collected from Missouri's air monitoring network. NO_2 and SO_2 design values for 2020 to 2022 were obtained from the Blair Street monitor located in St. Louis, Missouri (AQS ID: 29-510-0085). This monitor was chosen based on the relative proximity to the GPM facility.

[5] USEPA released a guidance memorandum on April 30, 2024, *Supplement to the Guidance on Significant Impact Levels for Ozone and Fine Particles in the Prevention of Significant Deterioration Permitting Program*, recommending a revised annual $PM_{2.5}$ SIL of 0.13 μg/m^3 and continued usage of the existing SIL values for ozone and 24-hour $PM_{2.5}$, effective May 6, 2024. The results from the Modeling Unit analysis are still below the newly recommended SIL values.

GPM was provided an inventory of sources from the Modeling Unit that included sources located within a 10 km radius from the facility. The Modeling Unit also obtained inventory sources from the Missouri Department of Natural Resources Modeling Unit to include in this analysis since the GPM facility is located in close proximity to the Missouri border.

For the 1-hour NO_2 analysis, intermittent sources were excluded from the nearby source inventory based on guidance issued by the USEPA in 2011.[6]

The modeled concentrations included impacts from the facility and nearby emission inventory sources. The total concentrations are the summation of the modeled concentrations and background concentrations, and these impacts are compared to the respective NAAQS, as shown in Table 3. **Table 3** shows NO_2 and SO_2 modeling results provided by GPM. The results of the modeling analysis indicated that annual NO_2 and 3-hour SO_2 emissions would be below their respective NAAQS values.

Table 3
NAAQS Modeling Results

Pollutant	Averaging Period	Modeled Concentration ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
NO_2	1-Hour	118.00(1)	84.98(a)	202.98	188.14
	Annual	13(2)	20(b)	33	100
SO_2	1-Hour	589.57(3)	28.56(c)	618.13	196.32
	3-Hour	431(4)	27.0(d)	458	1,300

(1) Average of the 8th highs over five years.
(2) Highest annual high value over five years.
(3) Average of the 4th highs over five years.
(4) Highest 2nd high value over five years.
(a) Three-year average of the 98th percentile daily max 1-hour values.
(b) Highest annual concentration over three years of monitoring data.
(c) Average 99th percentile concentrations per year over three years.
(d) Highest 2nd high concentration over three years of monitoring data.

As **Table 3** indicates, GPM reported modeled exceedances of the 1-hour NO_2 and 1-hour SO_2 NAAQS. An analysis was performed to determine if GPM would cause or contribute to these modeled exceedances of the NAAQS by comparing GPM's contributions to modeled exceedances to their respective SILs.

For the 1-hour NO_2 analysis, GPM's contribution to the total maximum modeled concentration of 202.98 $\mu g/m^3$ was 0.02 $\mu g/m^3$. The maximum 1-hour NO_2 contribution from GPM to a modeled exceedance was 4.75 $\mu g/m^3$. Both of these values are less than the 1-hour NO_2 SIL of 7.52 $\mu g/m^3$ which indicates that GPM is not causing or contributing to an exceedance the 1-hour NO_2 NAAQS.

For the 1-hour SO_2 analysis, GPM's contribution to the total maximum modeled concentration of 618.13 $\mu g/m^3$ was 0.01 $\mu g/m^3$. The maximum 1-hour SO_2 contribution from GPM to a modeled

[6] USEPA (2011). *Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard.*

exceedance was 7.23 µg/m^3. Both of these values are less than the 1-hour SO_2 SIL of 7.85 µg/m^3 which indicates that GPM is not causing or contributing to an exceedance the 1-hour SO_2 NAAQS.

Summary

The Modeling Unit has reviewed the air quality analysis provided by GPM. The Modeling Unit audit of this analysis confirms that GPM's proposed operation would not exceed the NAAQS for any CO, NO_2, or SO_2 averaging times. The audit also confirms that emissions of VOM, NOx, and SO_2 would not have significant impacts on $PM_{2.5}$ and ozone formation.

cc: Bill Marr, Section Manager, Permits/BOA
Jason Schnepp, Construction Unit Manager, Permits/BOA
Cari Rutherford, Modeling Unit, Permits/BOA